Society for Chaos Theory in Psychology & Life Sciences

33rd Annual International Conference

Fields Institute, University of Toronto, Toronto, Canada

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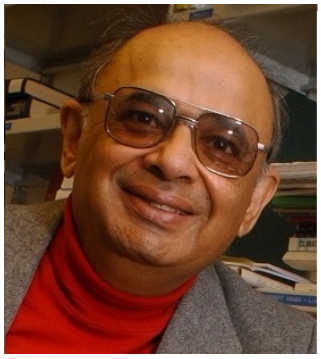
Bernard Ricca
Conference Chair

Our Guests...

Jonathan Butner



Mohammed Dore

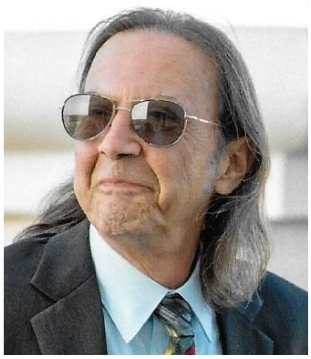
William Sulis

...and Workshop Presenters

Catface Muldoon

Adam Kiefer

David Pincus



Stephen Guastello

Abstracts in Alphabetical Order by Author

Cortney Armitano-Lago, Elizabeth Bjornsen, Caroline Lisee, Louise Thoma, Troy Blackburn, Jeffrey T. Spang, Adam W. Kiefer, and **Brian Pietrosimone,**
University of North Carolina, Chapel Hill

A longitudinal assessment of lower extremity coordination patterns during gait within 6 months following anterior cruciate ligament reconstruction

Less variable lower limb joint coupling strategies increase localized stress on knee joint tissues. While 50% of individuals who undergo anterior cruciate ligament reconstruction (ACLR) develop posttraumatic osteo-arthritis, it is unclear how the underlying coordination dynamics during gait differ from uninjured controls. We conducted a longitudinal assessment to compare gait coordination profiles of individuals 2-, 4-, and 6-months post-ACLR to a coordination profile of uninjured controls. Thirty-four people post-ACLR (age: 21±4years; 65% female) and 34 controls (age: 21±3years; 65% female) participated. Walking gait kinematics were collected in the ACLR group at 2, 4, and 6 months post-ACLR and in the control group at a single assessment. Cross-recurrence quantification analysis was used to characterize sagittal plane ankle-knee, ankle-hip, and knee-hip coordination patterns. Comprehensive GLMMs compared between-group coordination outcomes from each time point post-ACLR to the uninjured control session. A between-group effect of mean line was observed for each time point post-ACLR time points within the ankle-knee (F1,70=8.96; F1,68=8.05; F1,65=10.29; all p <0.05) and ankle-hip (F1,70=14.87; F1,68=13.50; F1,65=5.59; all p<0.05), respectively, and the knee-hip 4 (F1,68=38.95, p<0.05) and 6 months (F1,68=31.19, p<0.05) indicating, on average, stronger coupling over longer periods post- ACLR. A between-group effect of cross-max line at 4 (F1,68=12.34, p<0.05) and 6 months (F1,66=11.11, p<0.05) within the knee-hip was observed suggesting overall stronger joint coupling of the knee-hip within the ACLR group. These results indicate people within 6 months post-ACLR exhibit a distinct, stronger coupled, walking coordination pattern compared to uninjured controls which may increase localized joint stress and have long-term implications for knee joint health.

Faruk Aykan, Istinye University

Another approach to understand life and cancer

This review summarizes current biophysical approach to understand life and cancer. There is still not any comprehensive definition of life. From the perspective of biology, the characteristics of life can be categorized as cellular organizations, homeostasis, metabolism, growth, reproduction and heredity, response to stimuli and adaptation to the environment. From a physics perspective, living beings are thermodynamic systems with an organized molecular structure that can reproduce itself. According to the 2nd law of thermodynamics, every system in the universe is going to the disorder spontaneously. Maximum entropy signifies a thermodynamic equilibrium which means the death. Therefore, we can define the death more easily than the life physico-chemically. Energy must be used to produce a highly ordered organizations. The living organisms are highly ordered (complex) dynamic and thermodin-amically open systems and they are in non-equilibrium phase. In the open systems, the entropy increase is slow; living systems defy the entropy. Dissipative structures (living organisms) exchange entropy and during this exchange they gain information from the external environment. Entropy is oppositely linked to the amount of information. Information can be stored as memory and it should be coded. In the solar system, life is possible only in the habitable zone that means not too cold, not too hot, just right position in the universe. Free oxygen production to the atmosphere by first photosynthesis from cyanobacteria which was crucially important for life is approximately 2.5 billion years ago. Another powerful force for life is evolution, because it supports adaptation of living organisms to the environment. The basic units of life are cells. There is an inverse relationship between function and multiplication in a functional tissue unit formed by living cells. In the optimum healthy state there is maximum adaptability with the environment and there are periodic oscillations between an input and an output in many physiological events. Highly ordered, complex adaptive dynamic systems have dynamic multilevel and modular structures and multiscale information flow. Every higher level in the biological systems is characterized by an emergent property that is not possessed by any of the lower-level precursors. Life is a category of emergence like art composed after the integration of correct modules. On the contrary, cancer is the emergence of a disease formed by incorrect modules. Cancer is a chaotic disease and cannot arise from healthy functional tissue units. Chaos of the lower level may be associated with the entropy increase of upper level. Biologic chaos control is possible. There are some successful examples, but we are at the beginning. Chaos control in cancer should be level by level. More and different efforts are needed to conquer cancer.

Yuki Bao, Biomedical Engineering, University of Western Ontario, Canada
Amelia C. Frisbee, Physics, University of Guelph, Canada
Jefferson C. Frisbee, Medical Biophysics, University of Western Ontario, Canada
Daniel Goldman, Medical Biophysics and Biomedical Engineering, University of Western Ontario, Canada

Constructing Fractal Networks to Study Microvascular Physiology and Pathophysiology in Rat Skeletal Muscle

At the organ and tissue level, the circulation relies on branching networks of microvessels to supply oxygen and other nutrients to all cells in support of metabolism, as well as remove metabolic waste, and derangement of the structure or function of these networks is directly linked to tissue dysfunction. Over a wide range of diameters, these

networks are binary trees and display fractal geometric and hemodynamic properties. Although experiment-based reconstruction of these vascular structures has improved recently, there remains a strong motivation for developing theoretical models that match measured statistical properties of microvascular networks under healthy conditions and with elevated disease risk (e.g., diabetes) and can be used for computational studies of flow, transport, and regulation. These efforts have the ultimate goal of connecting specific vascular defects to observed modes of tissue dysfunction. In the present study, two-dimensional arteriolar networks in rat skeletal muscle are constructed based on the constrained constructive optimization (CCO) algorithm using published geometric and hemodynamic data obtained via intravital video-microscopy. Results obtained assuming blood is a single-phase Newtonian fluid demonstrate how network geometry, fractal dimension, and flow properties depend on the Murray law exponent (g). In addition, using a two-phase (plasma and red blood cells) flow model, we show the importance of microvascular blood rheology in determining network properties. Future work will focus on constructing three-dimensional networks, tissues other than skeletal muscle, and determining the effects of both domain shape and g.

Charles Benight, Bernard Ricca, Lyda Hill Institute for Human Resilience at University of Colorado, Colorado Springs
Pascal Deboeck, Psychology Department, University of Utah
Alex Stover, Lyda Hill Institute for Human Resilience at University of Colorado, Colorado Springs

Using Dynamic Systems Analysis to Gain Insight into Post-Trauma Distress

Relationships between posttraumatic growth, perceived self-efficacy, and distress in trauma survivors have been studied previously. However, those studies have modeled only the reported levels of those quantities and not their speed (the rate at which they change) or acceleration (the rate at which the speed changes) of those quantities. The failure to include speed and acceleration in the modeling has limited the insight into the dynamics of post-trauma distress and resulted in inconsistent empirical results. This investigation used data collected from wildfire survivors daily over a period of 30 days and a model including speed and acceleration to gain new insights into post-trauma dynamics and to generate hypotheses about the origin of some previous inconsistent results in the field. We found that the speed at which self-efficacy increases ("mastery") decreases distress. Additionally, the inter-action between the level or speed of self-efficacy and the acceleration of post-traumatic growth significantly improved the prediction of change in distress and provided insight into notions of "real" and "illusory" post-traumatic growth (and subsequent unsustainable decrease in distress).

Aalina Bilal, University Of Toronto

Dynamic Systems Theory: An Important Discussion in Cognition

This paper discussed whether dynamic systems, as a mathematical theory, and dynamicism, as a theoretical framework, are both necessary and sufficient in an accurate model for understanding cognition. The importance of time and environment are central in its integration with cognitive science and brain behaviour modelling. However, with parts of the theory mirroring what we see functionally in cognition, there are some theoretical and practical limitations to the theory. Our findings include that a) theoretically, dynamic systems can model neuron function, salience mapping and receptive fields well b) dynamic systems alone run into problems of sigmoid activation c) coupling dynamic systems with other theories provide more impressive results and d) the theory itself lacks internal represent-tation of goals and long term memory. All of these findings are important for furthering our understanding about what part of dynamic systems should remain active in the field of cognitive science and where issues arise often enough to force us into over-simplifying our theories and losing that important information.

Marie-Laure Blanc, Private practice, Aix les Bains, France

Words as Fractals: Bridging the Gap between Appealing Concepts discussed at Conferences and the not so Appealing Reality Experienced on the Shop Floor

To address complexities, leaders often rely on concepts that they then talk about when they go on stage. From Agile to Positive leadership, all come with the promise of ' putting the human dimension at the heart of corporations.' Yet, on the shop floor, the number of employees burnt out or bored out shows that the Human dimension is rarely at the heart of corporations. Instead of pointing out the age-old gap between words and action, what if we consider that there is in fact a gap between two categories of words: those said on stage (Universe 1) and those said every day on the shop floor (Universe 2). The challenge for leaders is thus to consider that each word of their daily conversations (Universe 2) is a fractal of the concepts they talk about when on stage (Universe 1). This challenge implies to: 1. Adapt Mandelbrot's definition of a fractal (1983) to the spoken word and thus consider daily conversations (Universe 2) as a ' reduced-size copy of the whole' (Universe 1). 2. Address the complexity linked to the fact that the same material, the word, is used in both Universes. 3. Use a question revolving around five processes: What should we: 1.Stop? 2.Start? 3.Continue? 4.Perform regularly? 5.Improve? Instead of the ' What should we do?' question that leads to linear answers. When leaders consider that each word they say every day is a fractal of the concepts they go for, they will put the Human dimension at the heart of corporations.

Jonathan Butner, University of Utah

I Know They Are Not Elephants, But All I See Are Trunks: Living in a Nonlinear Complex World

Stanislaw Ulam famously said “Using a term like nonlinear science is like referring to the bulk of zoology as the study of non-elephant animals.” The notion that we live in a complexity driven world is non-controversial. The controversy comes in how we operationalize it. With this in mind, I will reflect on what we can learn from the vast body of non-systems research in fields like psychology. This will entail an attempt at linking classically taught statistics to our systems equivalents along with the impacts of various methods from cross-sectional and ecological momentary assessments to the role of measurement. In the end, this will be a pitch to not throw out the baby with the bathwater, but instead to tactically draw upon the past to help us inform for a more complete sense of our phenomena.

Brian Castellani, Durham University,

The Atlas of Social Complexity: Mapping Complexity's Adjacent Possible in Psychology and the Life Sciences

Although the complexity sciences have done much to advance the social sciences, over the last decade the field has run into some hard situations ' thirteen to be exact. Some are self-imposed, others come from how 21st century science is conducted. Examples include ignoring the wider social sciences; privileging computational modelling over qualitative research; and being tone-deaf about the real world. These situations presently prevent the study of social complexity from becoming the disruptive, transdisciplinary field it originally sought to be in the 1990s when the complexity turn in the social sciences took place. Fortunately, a small but growing global network of scholars are charting new territory. They are part of a fresh turn in complexity, the social science turn, which fosters a transdisciplinary, social complexity imagination that, in one way or another, addresses the field's thirteen situations to create new areas of disruptive and highly innovative social inquiry. The Atlas of social complexity (forthcoming, Edward Elgar, 2024) charts this new territory, seeking to map its present future. Organised around five major themes ' (1) Cognition, emotion and consciousness, (2) Dynamics of human psychology, (3) Living in social systems, (4) Advancing a new methods agenda, and (5) The unfinished space, the Atlas functions as a tour guide, surveying over thirty leading-edge research areas (some still under construction) that readers can variously combine and develop. The Atlas is a practical guide for those seeking new ideas and new avenues of study to pursue, all in the hope of fostering the transdisciplinary social complexity imagination needed to address some of the biggest global challenges we, as a world community, presently face. The purpose of this paper is to focus on themes 1 and 2 and their relevance for complexity research in psychology and the life sciences.

Linda Chamberlain, Better Help, Holiday, FL

Creating a Nonlinear Narrative for Trauma: a Case Study

This workshop explores the use of a non-linear story telling approach to working with a trauma survivor. Often, when we are sharing something secret and painful about a traumatic event, telling the story from beginning to end creates a very high level of anticipatory discomfort. Using a nonlinear format to share painful memories can be helpful in guiding a patient through that experience. A case study using this technique will be discussed.

Roy Choudhury, University of Central Florida
Ryan Roopnarain, Rollins College

Distributed Position and Velocity Delay Effects in a Van der Pol System with Time-periodic Feedback

The effects of a distributed delay on a parametrically forced Van der Pol limit cycle oscillator are considered. Delays in self-excited systems, modeling time lags due to a variety of factors, have been discussed earlier in the control and modification of limit cycle and quasiperiodic system responses. Those earlier studies are extended here to include the effects of periodically amplitude modulated delays in both the position and velocity. A normal form or “slow flow” is employed to search for various bifurcations and transitions between regimes of different dynamics, including amplitude death and quasi-periodicity. The existence of quasiperiodic solutions then motivates the derivation of a second slow flow. A detailed comparison of results and predictions from the second slow flow to numerical solutions is made. The second slow flow is then employed to approximate the amplitudes of the quasi-periodic solutions, yielding close agreement with the numerical results. Finally, the effect of varying the delay parameter is briefly considered, and the results and conclusions are summarized.

Lisa Conboy, BIDMC at Harvard Medical School, Complexity in Medicine
Claire Cassidy, John Hopkins, Complexity in Medicine
Tanuja Prasad, Complexity in Medicine

Predicting persistence of effect in an acupuncture Randomized Controlled Trial

Purpose: Gulf War Illness (GWI), or chronic multi-symptom illness (CMI), is characterized by multiple symptoms. In 2013 our study team completed a Department of Defense funded study The Effectiveness of Acupuncture in the Treatment of Gulf War Illness. With our robust sample (n=104) we found a clinically and statistically significant improvement in physical function and pain following 6-months of treatment. We are currently conducting multiple secondary data analyses to better describe this complex disease and how healing may happen using acupuncture. Herein we report on our use of Structural Equation Modeling to model the mechanisms of change and improvement across the entire sample on the biological, psychosocial, and clinical levels. Methods: We used the data reduction technique of factor analysis to better understand the differences in clinical, psycho-social, and experiential variables by treatment group (weekly versus biweekly treatment). We next completed a

longitudinal analysis of outcome differences by dose at 2, 4, and 6 months, and long term follow up (3-5 years). Results: We found 5 independent factors at baseline: belief/expectation, physical/psychological health, social network, social support, relationship with treatment practitioner. These are used to predict different types of responders at endpoint. Conclusion: Studying responses to acupuncture may elucidate mechanisms, subgroups of the disease, and inform the study of other CMI. Results can be applied clinically to design effective protocols and better understand how different doses of treatment work differently. Understanding associations with the persis-tence of treatment effect can help us better understand how healing happens.

Mohammed H. I. Dore, Brock University

Recurrent Financial Crises and the US Federal Reserve: Bubbles and Blisters

In this presentation I examine the evolution of the financial system whereby the central bank controls a part of the money supply, but brokerage houses and other financial institutions, called the "shadow" banks, issue a growing amount of the money supply, which remains outside the control of the central bank, the US Fed. Being unregulated, these shadow banks operate by taking risks in the amount of credit they offer, leading to lack of confidence and consequent *run* on such banks. However, the banks themselves have undergone structural change and are themselves engaged in the same activity as the shadow banks. Hence the distinction between banks and shadow banks is now moot. Consequently, almost all large financial institutions operate exactly like the brokerage houses and shadow banks, and are now also heavily engaged in speculative derivative futures trades. That is the second structural change: the derivatives market now determines the prices not only of financial futures but also the prices of all traded commodities, soft and hard. The dominance of the derivatives markets has led to strong oligopolistic market power, which is largely unregulated and sees only sporadic regulatory action in the US. The unchecked growth of speculative activity in the futures markets has raised commodity prices and also increased price volatility. This in turn has rendered the entire financial system including the banking system to become unstable, leading to bank runs and financial "bubbles."

Stephen Guastello, Laura McGuigan, Henry Vandevelde, Ryan Hagan, Cooper Bednarczyk, and **Anthony Peressini**, Marquette University

Team Situation Awareness, Cohesion, and Autonomic Synchrony 2: Group-level Effects and their Combined Influence on Team Performance

Situation awareness (SA) is a mental state that is instrumental to performance of complex dynamic tasks. It consists of three stages ' knowing the facts about a situation that could be changing rapidly, formulating a mental model of how the situation and facts are operating, and anticipating correctly the outcomes of further action. The development of SA within groups and teams is thought to be supported by favorable social conditions within the team. Thus the present study followed from earlier work on causal relationships among SA, group cohesion, and autonomic synchrony, the latter being a fundamentally nonlinear process. The present study assessed the combined impact of the three variables on performance in a dynamic decision task. Experimental manipulations were changes in task difficulty, group size, and method of obtaining SA measures. Participants 32 teams of 3-5 undergraduates performing a dynamic decision task that consisted of two matches of a first-person shooter computer game. They also completed self-report measures of cohesion and SA. Synchrony was determined through time series analysis of electrodermal responses using the driver-empath framework. ANOVA results showed that cohesion and SA improved over the two matches, and SA was better in smaller groups. Synchrony was stronger in larger groups. Granger regression indicated no causal or reciprocal relationship between SA and cohesion. Synchrony had a small positive effect on cohesion during the first match, which dissipated afterwards. SA had a strong negative impact on synchrony early on, which also dissipated afterwards. The best performing teams were the larger groups, those that were measured for SA without pausing the simulation, were less synchronized, showed better SA, and reported stronger cohesion. The study opens new questions concerning the role of synchrony in situations requiring different amounts of task versus social focus, threat levels imposed by gaming opponents, and role of automated teams operating alongside the humans.

Stephen Guastello and **Noah Osowski**, Marquette University

Catastrophe Modelling for Time Series of Reported Cases of COVID-19: Workload Effects in the Health Care System

This project began with the observation of time series trends in the number of COVID-19 positive cases that were reported in each of the 50 US States. At one level of observation there was a weekly cycle of high and low numbers of cases. At the second level that spanned there were visible waves of higher and lower numbers of reports. At the third level, there was a distinctive onset of variability during the peak times of positive reports of cases. The present study examined the possibility that the variability during peak periods was a nonlinear dynamical footprint of cognitive workload in the health care system. Our analysis of time series data from the state of Arizona from March 2020 to October 2021 showed that the swallowtail catastrophe model accounted for the occurrence of waves, and the cusp catastrophe model applied to the residual variance accounted for variability at the peaks. The two functions accounted for 97% of the variance in positive case reports over time. Implications for the management of future pandemics are discussed.

Chris Hardy, Eco-Mind Systems Science, Tarn et Garonne, France

A Retrocausal Attractor in the brain modelling the self-organization of the brain/ego: Self system, building the dynamics of intention and self-awareness

Extending a complex network-dynamical theory (SFT) postulating mind as a syg-field--multilevel, multidimensional, system of task-oriented semantic/syg-constellations--self-

organizing via a tachyonic, hyper-dimensional, syg-energy (Hardy 1998, 2015). Given (1) the experimentally proven nonlocal (beyond-spacetime) dynamics of several psi capacities (i.e., precognition); (2) Pauli, Jung, and SFT positing the unconscious (and Self) to be trans-spatial/temporal (i.e., hyperdimensional, HD) and extended over space-time (e.g., synchronicities); (3) the faster-than-lightspeed syg-energy, launching semantic links along syg-parameters (control parameter: semantic proximity): the mind-brain interface is ex-pounded as a HD Retrocausal-Attractor (RC-A) setting a feedback loop that self-organizes the Mind-Body-Psyche system through a double-correction process built-in the mind (at sub-quantum HD scale)--alike feedback self-organizing neural networks. A separate state-space plotting shows proactive influences (mental, material) on an event-in-making-constellation (F) as changing weights of probability lines in-forming several and pointing one specific outcome/attractor. The RC-A models intention and decision as the semantic-dynamical interplay of proactive influences on F, and retroactive ones on the operator. My current research into modelling the RC-A uses Bo-Wen Shen (2022) higher-dimensional Lorenz Model where there coexists a chaotic and two point-attractors (Past, Future). Chaotic orbits (outer region) show the conscious-flow (+unconscious/contextual input) in-forming an extended present (the saddle), influenced by past memories/behaviors (P) and the feedback loop from the intended or anticipated event in making a constellation (F). Complexified, the RC-A accounts for thought-complexification, negentropy, self-awareness and control, and ethical conscience: a second, orthogonal, Lorenz Model--with the two centers of consciousness (hyperdimensional Self+syg-energy, and ego in space-time) being its point-attractors--sets an ego-Self double-correction dynamics, and moreover exemplifies the spacetime-HD interlacing and inter-influence.

Adam Kiefer, Dominic Willoughby, Nikki Aitcheson-Huehn, Cortney Armitano-Lago, Ryan MacPherson, University of North Carolina at Chapel Hill, **Kelly Cohen,** and **Paula Silva**, University of Cincinnati

Poised for performance: A preliminary analysis of preparatory neuromuscular dynamics and functional reaction time in a sport-like virtual reality task

Enhancing athletic performance requires adaptive neuromuscular dynamics, which involve increased intermittency. Intermittency is a distinctive characteristic indicating a system's delicate balance between stability and instability. At the pinnacle lies metastability, which enables seamless and efficient transitions among transient, stable states of motor behavior. This study investigated the impact of task loading' i.e., the presence or absence of virtual defenders' on neuromuscular dynamics during an over-ground moving target interception task in virtual reality (VR). Contact sport athletes (N=17, 5 female, M age=20.47 ± 1.50 years) wore a VR headset, and EMG sensors on eight lower limb locations: this analysis focuses on the left and right quadriceps and medial gastrocnemius muscles. Participants were presented with an open field or three virtual defenders before a moving target appeared, and they ran to intercept it while avoiding any defenders. Recurrence quantification analysis was applied to the first 230 ms of EMG data following target onset. Functional reaction times (fRT) were also computed for each trial, defined as the time each athlete took to move 0.5 m in Euclidean distance from their origin. Paired-samples t-tests revealed increased intermittency in left quadriceps and gastrocnemius activation (lower trapping time and vertical line max) when defenders were present (all $p < .027$). Moreover, significant negative correlations were found between these measures and fRT across all four muscles (all $r > 0.53$). These findings demonstrate that task load affects preparatory neuromuscular activation dynamics in contact-sport athletes, potentially informing enhanced training practices through the identification of signatures of neuromotor adaptability.

Heidi Kloos and **Michael Droboniku**, University of Cincinnati

Exploring the Complexity in Motivation: A Review

In the current paper, we present a systematic review of research that sought to link complexity to questions of learning motivation. Specifically, we identified three ways in which of complexity science can be used to understand a behavior: One way is in terms of the fluctuations that are present in the behavior of complex systems. The second ' more elaborate way is in terms of understanding the nature of fluctuations, for example with the use of long-range correlations. Finally, the third ' most elaborate ' way of using complexity is in terms of identifying the control parameters that make up the attractor space. The resulting list of publications (N = 12) explored motivation either as the behavior of a complex system (67%) or as a factor in higher-order behavior of the system (33%). A majority of publications focused on second-language learning (58%). Results show that motivation can indeed be treated as a complex phenomenon, whether due to the interplay of stability and instability (83%), the presence of attractor states (42%), or the circular interactions among aspects that define the system (42%). Based on these findings, we discuss next steps towards establishing a complexity framework for motivation.

David Kreindler, University of Toronto

Identifying Mood Symptom Motifs in Time Series using Dynamic Time Warping

Background: If patterns exist in mood dynamics, this would be consequential for the prediction of mood disorders. Dynamic Time Warping (DTW) is a method that enables identification of ' fuzzy' (approximate) matches in time series data. DTW was used to explore whether repeated conserved sub-sequences ('motifs') could be identified in extended, high-accuracy mood symptom time series. Methods: Using a database of self-report questionnaires rating the severity of 11 mood symptoms that were collected every 12h over 1.5 years from 19 subjects with rapidly-cycling bipolar disorder and 19 age- and sex-matched healthy controls, DTW was used to calculate measures of similarity between normalized sub-sequences of 14 or 28 points (i.e., one or two weeks' duration) within individual symptom severity time series. Receiver Operating Characteristic (ROC) curves were created on a subset of the data to determine optimal similarity measure cut-off values, enabling automated motif identification across the entire data set. Results: One or more motifs were identified in most but not all symptom severity

time series. However, regardless of sub-sequence length or change to the ' warping window' size, the number of motifs identified from the time series was not significant compared to the motif counts from randomly permuted versions of the original time series. Conclusions: While motif analysis of normalized mood symptom time series using DTW does identify motifs pairs and some motif clusters, the results obtained using randomly permuted time series suggest that, in this analysis, our DTW-based fuzzy matching method may be identifying matches where none in fact exist.

Wei Shan Lee, Hou Fai Chan, Ka Ian Im, Kuan Ieong Chan, and **U Hin Cheang**, Pui Ching Middle School Macau

Predator Extinction arose from Chaos of the Prey: the Chaotic Behavior of a Homomorphic Two-Dimensional Logistic Map in the Form of Lotka-Volterra Equations

A two-dimensional homomorphic logistic map that preserves features of Lotka-Volterra Equations was proposed. In order to examine the Lotka-Volterra chaos, in addition to ordinary iteration plots of population, Lyapunov exponents either calculated directly from eigenvalues of Jacobian of the 2D logistic mapping, or from time-series algorithms of both Rosenstein and Eckmann et al. were calculated, among which discrepancies were compared. Bifurcation diagrams may be divided into five categories depending on different topological shapes, among which flip bifurcation and Neimark-Sacker bifurcation were observed, the latter showing closed orbits around limit circles in the phase portrait and phase space diagram. Our model restored the 1-D logistic map of the prey at the absence of the predator, as well as the normal competing behavior between two species when the initial population of the two is equal. In spite of the possibility for two species going into chaos simultaneously, it is also possible that with the same inter-species parameters as normal but with predator population 10 times more than that of the prey, under certain growth rate the latter becomes chaotic, and the former dramatically reduces to zero, referring to total annihilation of the predator species. Interpreting humans as the predator and natural resources as the prey in the ecological system, the aforementioned conclusion may imply that not only excessive consumption of the natural resources, but its chaotic state triggered by overpopulation of humans may also backfire in a manner of total extinction on human species. Fortunately, a little chance may exist for survival of human race, as isolated fixed points in bifurcation diagram of the predator reveal.

Sam Leven, TPI, Ft. Lauderdale, FL

Humans as Systems of Systems

The elderly among us recall the radical claim, “The computer is the network,” the argument [eventually victorious] that defining the operations of an isolated electrical box as knowledge processing understates the value of the invention. The study of human health and behavior faces a similar dilemma. As Cianucca and Levin write, cognition can be seen as a multiscale web of dynamic information processing distributed across a vast array of complex cellular (e.g. neuronal, immune, and others) and network systems, operating across the entire body, and not just in the brain. [bioRxiv 2023]. We argue, with an experiment to illustrate our claim, that we must consider humans to contain [many] interacting systems ' and these are embedded in environments [social, physical, cultural] which continually co-adapt with them. We heal in contexts. We shall demonstrate that Non-Invasive Brain Stimulation [NIBS] may have benefits across several organs, enhancing the patient's ability to thrive in multiple ways. Understanding these dimensions allows isolated treatments to enhance health beyond the defined therapeutic “target.” An impressive case of the benefits of recognizing the dexterity of human biochemistry is the gene protein complex Brain Derived Neurotrophin Factor. My group believes a standard psychological therapy, Transcranial Magnetic Stimulation [TMS], may be able to address a variety of diseases pervasive among human organs. As Pasquale Leone [2023] summarized, TMS treats a variety of affective and behavioral disorders by stimulating the production of BDNF and by increasing connectivity among targeted brain regions. This non-invasive procedure mitigates the effects of organic conditions as well, including Alzheimer’s disease and Parkinsonism among others. Pascual Leone has reported that TMS patients with heart conditions have often reported improved cardiovascular function; he emphasizes these are correlational results which remain to be fully tested. But the apparent systemic effect of the increase in BDNF is suggestive. The brain produces seventy-five percent of the body's BDNF. And, while exercise provides a modest increase [associated with enhanced mood and learning], there are limits to its effects. Yet demands for increases in BDNF are not modest. Kermani and Hempstead [2019] tell us BDNF heels the cardiovascular system by modulating contractility, migration, neoangiogenesis, aptosis and survival of a variety of critical cells. Ye and associates [2022] determined BDNF plays a crucial role in preventing bone loss and promoting bone formation. Zhang et al [2023] found that BDNF promotes supply of airway smooth muscle cells mitigating asthmatic conditions. Jameson's group [2022] found skin barrier integrity crucial to resisting environmental triggers of infection and immune processes in which BDNF plays a crucial role. Perhaps most surprising is the centrality of BDNF in the pro regenerative healing produced by extracellular signal related kinase [ERK, Seifert 2023]. We propose to test the increased availability of BDNF for organ healing. We shall measure organ-specific blood proteins before and after a TMS program [thirty-six treatments] among healthy naïve patients. A significant increase in those levels may indicate TMS could provide critical aid to a number of patients. We expect this to be among a common inquiry, treating whole humans.

Sam Leven, TPI, Ft. Lauderdale, FL
Nate Shanok, Florida Atlantic University

TMS for Resilience and Enhanced Cognitive Reserve

Our goal is optimizing resilient, cognitive processes; we employ accepted therapy in a novel approach. Our immediate target population: elite athletes. Our protocol involves a leading college football program. Our methods should be applicable to precision medicine generally. We adopt the hypothesis that brain stimulation can not only provide well understood affective, motor control, and cognitive benefits but also enhance resilience to brain

injuries -- preventing substantial damage by concussion which recently has been shown to increase susceptibility both to CTE and even more tragically to Alzheimer's disorder. Our approach involves the leading non-invasive brain stimulation [NIBS] technology, Transcranial Magnetic Stimulation [TMS]. TMS, a thirty year old therapy, employs directed magnetic fields to key areas whose processing is slow or inefficient. It has been employed to treat Major Depressive Disorder, OCD, PTSD, and Schizophrenia, et al. Additionally, motor dyscontrol has been mitigated. New applications have included Alzheimer's and dementias [Pascual-Leone, 2023]. Evidence has proved that TMS provides remarkable benefits for attention, recall, and openness to new ideas [including counseling]. For competitive players, the instantaneous pattern recognition and disinhibited attention suggest advantages at the core of football. An offensive lineman who is milliseconds quicker to recognize the quarterback's snap count and the defensive line's attack has enormous advantages; these expand as the players tire and are slow to attend. Further benefits obtain from the increase in cognitive reserve engendered by increased interregional connectivity. The resilience developed tends to minimize the effects of moderate brain trauma ' and should speed recovery. We propose to test our approach in the coming year.

Becky Neufeld and **Jonathan Butner**, University of Utah

The Thirty Body Problem: Interpreting Multidimensional Dynamics at an Item Level

Psychology has long used multi-item scales to capture phenomena. If we consider these items as taping into a multi-dimensional system, we have a problem where many of the items act nearly identically over time. Therefore, using multi-item scales to measure a system's dynamics (attractors, repellors, saddles and limit cycles) can prove challenging because it is often unclear which items are contributing to a system's underlying dynamics as well as the optimal axes that distinguish between attractive/repulsive and cyclic behavior of the system. Plenty of work has utilized the eigenvalues from the Jacobian matrix to map the primary dynamics in large multi-dimensional systems. Building on this, we draw on the parallels between the Jacobian and Factor Analysis to reinterpret the results in terms of what measurement items uniquely describe underlying dynamics. We envision this as a two-stage process paralleling exploratory factor analysis. First, we calculate the eigenvalues of a dynamic system to determine the dimensional space in which the equations function and keep only the ones that are uniquely describing the system. Secondly, we rotate these values using a varimax rotation to determine which measurement items are contributing to which dynamics. For this talk we propose using simulation examples of common psychological systems under different conditions (i.e. sleep and stress in coupled and uncoupled scenarios with varying amounts of measurement and dynamic error) to demonstrate the validity and utility of this approach for reducing multiscale measures into a manageable and interpretable number of items that optimally describe the underlying system.

Abigail Ortiz, University of Toronto
Garmham Julie, Slaney Claire, Nova Scotia Health
Alda Martin, Dalhousie University

Good days and bad days: using time-series analysis to understand mood regulation

Mood regulation is a complex and poorly understood process. In this paper, I will give an overview of our theoretical model to understand mood regulation using time-series analysis. This is a new perspective that is clinically relevant to understand how mood regulation differs in people without any mood disorder, in patients with mood disorders (bipolar disorders) and their unaffected first-degree relatives. I will discuss our findings in relation to two different studies in clinical populations, which showed that mood regulation in unaffected first-degree relatives is indistinguishable from the one seen patients with mood disorders. We will discuss potential future applications of these findings, in particular to forecast episodes of illness.

Martin Pham, University of Toronto

Roadmap for a neuromorphic alternative to bispectral index monitoring

Bispectral index (BIS) monitoring is a widely used method in anesthesia management to assess the level of consciousness and depth of anesthesia; however, exploring alternative approaches that leverage advancements in neuromorphic computing, particularly through Spiking Neural Network (SNN) modeling, which inherently captures the nonlinearity and chaotic dynamics of neural systems, holds promise in enhancing monitoring capabilities. In this talk, we present a roadmap for the potential development of a neuromorphic alternative to BIS monitoring, emphasizing the utilization of SNN modeling and its relationship to nonlinearity and chaotic dynamics to allow for personalized training of algorithms and improve anesthesia management. We discuss the challenges and opportunities in designing and implementing neuromorphic architectures that effectively capture the nonlinear and chaotic behaviors observed in neural systems, integrating machine learning algorithms tailored for SNNs, and the significance of comprehensive experimental studies for validating the proposed approach. Furthermore, we highlight the potential benefits of a personalized SNN-based monitoring system, such as improved accuracy, real-time feedback, and adaptability to individual patient characteristics, owing to the incorporation of SNNs ability to capture the nonlinear and chaotic nature of neural activity. This roadmap serves as a guiding framework for future research, aiming to advance the development of a robust and efficient neuromorphic alternative to BIS monitoring, leading to enhanced anesthesia care and patient safety through the utilization of SNNs inherent nonlinearity and chaotic dynamics.

David Pincus, Psychology, Chapman University

Get it together: Flexibility, Integrity, Resilience, and Psychotherapy

Linear models, reductionism, and disciplinary boundaries pull things apart into smaller and smaller pieces until independent and simple cause-effect relationships can be discerned. This myopic focus can be interesting when a particularly rare and useful linear cause-effect process is discovered. However, when over-applied, scientific over-simplification results in stagnation. This brief workshop will examine the problem of linear, reductionistic over-simplification in the context of human resilience and psychotherapy, two areas that are core to understanding psychology, but that have been surprisingly stagnant in both science and practice. Applying self-organization as a theoretical framework removes a range of unnecessary conceptual, empirical, and practical barriers that contribute to this lack of progress. For example, networks, topologies, bivariate, and univariate dynamics may each be understood to be different models to be applied within a unified theoretical framework. Resilience may be understood to be a single process involving several dynamics: robustness, bouncing back, growth, and grit. Similarly, the various ' theories' of psychotherapy may be seen as a single process applied to past, present, and future mind-sets, across four broad experiential channels: emotion, cognition, interpersonal and behavioral dynamics. At a higher level, flexibility and integrity may be seen as complementary processes that are foundational to any useful theory of resilience or psychotherapy, rather than as opposite or independent processes. Finally, understanding psycho-therapy may be understood to be inseparable from understanding resilience because psychotherapy is fundamentally a resilience-building therapy, not a treatment aimed at some sort of cure.

Bernard Ricca, Lyda Hill Institute for Human Resilience at University of Colorado, Colorado Springs

Strange Attractors and Short Time Series

The identification of strange attractors requires time series that are much longer than are typically collected in psychological investigations. This has limited the application of nonlinear dynamics in empirical studies in psychology. However, by assuming that data are sampled from a system of strange attractors, new insights into short- and medium-term dynamics are possible using even short time series. Time series data can be used to estimate a number of attractor-like regimes that could describe the state space from which the data were collected. The sequence of transitions between these attractor-like regimes can then be used to identify trajectories of behaviors. As an example, this approach is applied to ecological momentary assessment data collected daily for seven weeks from a sample of 165 rural survivors of Hurricane Florence. This analysis resulted in 8 attractor-like regimes and 4 trajectories of behaviors. Significant differences between the regimes and some long-term outcomes of the trajectories were noted. Although a number of open questions regarding the method remain, these findings demonstrate the usefulness of the approach.

Alexander Stover, Bernard Ricca, Margaret Morison, Abbey Westphal, Michael Dolezal, and **Charles Benight**, Lyda Hill Institute for Human Resilience at University of Colorado, Colorado Springs

Examining Trauma Survivors' Structural Integrity during Study Tasks

Systems self-organize from complex interactions between their components. Reciprocal feedback from the system-as-a-whole to its components maintains this organization. Self-organization in living systems is adaptive as it enables them to alter structural organization in response to environmental demands. This study (N = 68) examined structural integrity' the degree of fit (R^2) between an observed distribution of heart rate variability (HRV) and an inverse power law (IPL)' as an indicator of self-organization. These data were collected from trauma survivors using an e-health trauma intervention, My Trauma Recovery (MTR). Data were gathered across five segments in a session that required participants to sit quietly, complete a cold-pressor task, watch a nature video, complete three modules from MTR, and discuss their index trauma. HRV is a continuous measure of individuals' physiological response to stress and reflects autonomic functioning. Thus, calculated degrees of fit indicate how each task affected participants' structural integrity. The results demonstrated a significant decrease in structural integrity during MTR module completion (R^2 = .89) compared to segments in which participants completed the cold pressor task (R^2 = .97) and sat quietly (R^2 = .98), $p <$ .05. This is the first study to utilize HRV and IPL to investigate short-term changes in structural integrity to our knowledge. The findings indicate that this approach provides a new tool for analyzing self-organization.

William Sulis, McMaster University

Contextuality in Human and Collective Intelligence Decision Making

Decision making is commonly considered from the altar of rationality – a logically perfect and optimal strategy based upon perfect, complete information, well ordered criteria, and infinite time. Any form of decision making which is not rational is termed “irrational”, and so must be lesser, debased, flawed, illogical, deranged, compared to its ideal counter-part. In real life, however, one has imperfect, incomplete information, finite time, multiple conflicting criteria and changing conditions. Nature has evolved to utilize different decision-making strategies in differing contexts. Non-rational is a better term to describe effective, contextual, decision making under suboptimal conditions. Multiple examples of non-rational decision making among humans and social insect colonies will be presented, highlighting the role of contextuality. The fundamental role played by contextuality demands that the statistical analysis of decision making utilize contextual or non-Kolmogorov probability, similar to the mathematics involved in quantum mechanics. In quantum mechanics, contextuality is presented as violation of the Bell inequalities by correlations among measurements. An analogue of these Bell inequalities, relevant to psycho-logical measurement, has appeared in the literature, and it too has been shown to be violated in certain psychological experiments. This deep form of contextuality will be discussed.

Alexey Tolchinsky, The George Washington University

Assessment of chaoticity and entropy in models of consciousness, health, and pathology

I will review the current empirical evidence of chaoticity at various scales of the brain-mind and the application of nonlinear tools in clinical practice. Kolmogorov-Sinai entropy and its approximations for real living systems, such as ApEn, PeEn, will be considered for various states of consciousness in health and disease. I will discuss the general pattern observed in these studies, which is a correlation between EEG entropy measures and generalized arousal. Based on these data, I will propose a hypothesis that the brain-mind at various scales can operate in linear, nonlinear, or hybrid modes, such as chaotic functioning accompanied by noise. Further, I will review existing hypotheses formulated by Liley et al. of a possible phase transition into a chaotic mode of functioning at the level of alpha rhythm which shows weak nonlinearity. I will also consider a thesis formulated by Mark Solms that living systems must minimize Shannon's entropy of physical states (sensory entropy). Based on the empirical data, minimization of entropy in that sense appears to be describing only a part of the complex brain-mind dynamics. Studies evaluating measures of entropy specifically developed for real living systems such as discrete timescale entropy (ApEn) suggest that a decrease in EEG entropy can indeed be observed in some neuronal processes (e.g. progression from wakefulness to deep sleep); however, EEG entropy is observed to be increasing at other times and in other modes of brain-mind functioning (e.g. progression from deep sleep to REM to wakefulness; and from vegetative state to wakefulness). I will discuss the clinical implications, including the possibility of increasing diagnostic accuracy by incorporating nonlinear tools in the current diagnostic methods. I propose that it would be theoretically and clinically beneficial for future revisions of the models of consciousness and contemporary psychodynamic psychotherapy to consider including the chaos theory framework. This work has already started both theoretically, such as in Friston et al.'s (2021) paper that incorporates the Free Energy Principle with stochastic chaos, and in practical applications, including chaos-theory-informed algorithms in the assessment of epilepsy, prediction of recovery for patients in Minimally Conscious State and in other circumstances. Finally, I will discuss the model of consciousness and specifically an approach to the hard problem of consciousness proposed by Karl Friston and Mark Solms. I will highlight their use of a homeostatic mechanism for various phenomena, including affects and core consciousness. I will suggest possible limitations of this approach and propose possible directions for future revisions.

Irina Trofimova, McMaster University

Entropy reduction questioned: The "Throw & Catch" principle in natural systems

"Throw & Catch" (T&C) principle in neurodynamics refers to the pro-active, neurophysiologically expensive, massive and, therefore, a paradoxical topical increase of entropy ("Throw"). The Throw occurs within brain development, electrodynamics and neurotransmission whenever there is an uncertainty in the selection of degrees of freedom (DFs). The "Catch" systems are represented by the positioning of receptors and neurons that follows the strategic preferences of the body. The T&C in the nervous system also proceeds as the relay-like processes during the selection of DFs in behaviour at many neuro-physiological levels. The "Throw" works as an internally generated "flashlight" that, contrary to the expectations of entropy reduction, locally increases entropy and variance observed in the processes related to orientation and action formation. The neural regulation of behaviour appears to be a fluid, constructive process, constantly upgrading the choice of behavioural DFs, to ensure the compatibility between the environment and an individual's needs and capacities. The T&C is common in nature, including natural selection. This suggests that regulatory mechanisms in biological and social systems go beyond quantum mechanical algorithms, even though they use stochastic dynamics. These mechanisms also contradict "entropy reduction" principle advocated by Friston and others but supports Walter Freeman's work on anticipatory chaotic attractors in neurodynamics.

Mike Unrau, University of British Columbia

Novelty, and its Assessment: A Multidisciplinary and Complex Systems Approach

Most scholarly discussions of novelty offer only partial or specified views of what it is or how it can be assessed particular to a discipline or are limited to individual studies. This paper presentation investigates novelty with the goal of offering a multi-systemic and generalizable definition and assessment process to be applicable across multiple disciplines. Novelty is proposed as a quality and state, which includes both a qualitative view that integrates subjective experience and a quantitative view that addresses nonlinear dynamical systems. It is also described as a comparative relatedness of space, time, and context. An 'outlier profile' is defined to search for features of the system that are original or unusual, and a 'low-recurrence profile' for features of the system that are unexpected or a surprise. A detailed research strategy is offered for novelty assessment with an example, and is usable across multiple disciplinary contexts in the sciences and humanities for studies of academic and practical use.

Ilse Wambacq, Montclair State University
Koen DePryck, Vrije Universiteit Brussel

Complex socio-cognitive dynamics of age-related changes in challenging listening experiences

Traditional clinical approaches are often too linear to grasp the complex dynamics which result in functional disabilities people perceive in their daily functioning. Persistent difficulties perceiving speech in adverse listening conditions (such as in a restaurant or at a party) are a common experience for people as they age, even when clinical evaluation of the hearing mechanism is non-indicative of hearing loss. Cognitive and psychological factors are at play, but all too often audiologists do not consider those when diagnosing or counseling their patients. The complex nature of contributing factors to acoustically degraded speech perception calls for a novel and interdisciplinary approach to the diagnosis of communication impediments for which no linear cause can be found. In our paper we provide evidence

that non-linear dynamics can be used to build a socio-cognitive network model of speech perception. We imported publicly available data from the MIDUS study (1995), which contains results from speech perception, cognitive and psychological self-report scales and tests. We conducted a network analysis on the data of 119 adults, ranging in age from 34 to 83 years, and found that socio-cognitive networks varies as a function of the degraded listening experience. Using a network analysis of the socio-cognitive profile of people with speech perception difficulties provides an innovative approach towards exploring solutions for those who are otherwise left without any insight into their listening problems. We look into examples involving the complex dynamics among age, anxiety, divided attention and executive functions during challenging listening experiences.

Loris Zhu, Math and Philosophy, University of Toronto

Fractalism: The Correlation between Consciousness and Fractals

Fractals are complex geometrical shapes with a self-similar pattern that repeats itself at different scales. Research has suggested that fractals might be fundamental to the functioning of the brain and the processing of information. The concept of *fractalism* proposes that consciousness, the state of being aware of one's surroundings, thoughts, and emotions, is correlated with fractals, which is a theoretical framework that posits that fractals are not just a mathematical curiosity or an aesthetic pleasure but are fundamental to the functioning of our consciousness. According to this theory, fractals exist at the core of the brain's information processing and have a profound impact on our perception, cognition, and creativity. This theory explores the philosophical implications of fractalism and its relationship with consciousness, and how can it help to build a real conscious AI, it also compares fractalism with other philosophical theories such as dualism and functionalism, and how fractalism challenges the traditional view of the mind-body problem and suggests that the mind and body are interconnected and interdependent.

Mikhail Zimin, 2554620 Ontario LTD.
Olga Kumukova, High-Mountain Geophysical Institute, Nalchik, Russian Federation
Svetlana Zimina, 2554620 Ontario LTD.

Origination of Eskov Chaos as a Precursor of Failure

In some manuscripts of V. M. Eskov, statistical instability of samples for living systems is described. This effect was called as Eskov chaos. Further researches showed that this phenomenon may be a precursor of failure. For instance, such phenomenon is observed for precipitation rate. It results in Eskov chaos in avalanche risk. Also, it causes Eskov chaos in estimations of mud flow danger. So, taking into account this factor is important in forecasting slope processes connected with destruction of snow or soil. Other example is Eskov chaos in the biological forerunners of earthquakes. In particular, chaotic motion of rats was on display many times before earthquakes at North Caucasus. Therefore, it preceded failure of rock. Given examples show that analysis of statistical instability of samples may be useful for estimating risk of failure of various objects. References 1. Eskov, V. V., Phenomenon of statistical instability of the third type systems ' complexity / V. V. Eskov, T. V. Gavrilenko, Y. V. Vokhmina // Technical physics. ' 2017. ' Vol. 62(11). ' P. 1611 ' 1616.

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Taras Gavrilenko, Dmitry Gorbunov, Surgut State University
Maxim Zimin, 2554620 Ontario LTD.
Oksana Kulikova, The Siberian State Automobile and Highway University

Statistical Instability of Samples and Pseudo-attractors

Statistical instability of samples for living systems is described in several articles. This effect takes place for RR intervals, electromyogram, electroneurogram, and electroencephalogram. However, this phenomenon occurs not only in biological objects. For a long time, it has been observed in technical systems, where human factor is significant. So, necessity of development of new methodology for describing living systems is shown. One of its application is diagnostication of health conditions. Other actual use is taking into account human factor for adequate forecasting remaining life of equipment. Indeed, more qualified personnel can provide better maintenance and operation condition. Therefore, estima-tion of such influence and accompanying effects presents some features of interest too. In such situation the idea of a pseudo attractor may be interesting. It has a form of invariant set containing all phase paths. Wherein, different sizes of the pseudo attractor correspond to qualitatively different conditions. Besides that, form of pseudo attractors may also be helpful for diagnosing. For example, investigations were performed for electro-encephalograms of persons ill with epilepsy. They are ring-like, which is qualitative differ from these pseudo-attractors of health persons having rectangular form. Number of dimensions of pseudo attractors is greater by one, than number of dimensions of confidence intervals. Correspondently it gives more useful information.

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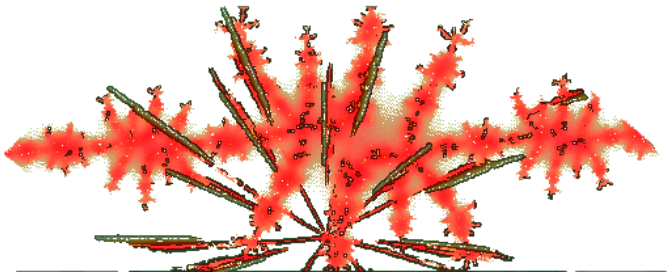
Estimation of Time Remaining to Dangerous State by Changing Average Risk in the Method of Ordered Risk Minimization

Despite considerable progress in dangerous states' forecast, computing time interval to their formation remains very complicated problem. Therefore, any technique helping to solve it presents some features of interest. In utilizing the method of ordered risk minimization, average risk is consequentially calculated for dependences beginning from the simplest. The one under which average risk is minimum is considered as providing optimum approximation of initial data. If, when using Chebyshev polynomials, optimum degree is equal to zero, situation may be considered as stable. However, due to the passage of time difference between average risk for n = 0 (n ' degree of polynomial approximant) and n > 0 may decrease. This suggests that optimum degree (nopt) will become more than zero after a

time, and situation will be unstable and may be treated as a catastrophe. This time can be estimated with the help of found approximations. Calculations are performed for analysis of the somatic temperature, modeling of stage ominous calm in rabies, and radiation sickness, evaluating degrees of expressiveness of biological precursors of earthquakes and mudflows. Knowing time to dangerous state, it is possible to take corresponding measures and avoid risk of loss of values and fatalities.

Call for Papers:

Special Issue of *Nonlinear Dynamics, Psychology, and Life Sciences* on Nonlinear Economic Dynamics, in memory of John Barkley Rosser Jr.



NDPLS is actively searching for manuscripts for a special issue to be entitled "Nonlinear Economic Dynamics," dedicated to John Barkley Rosser Jr. (1948-2023), in memory of his outstanding contributions in the field of nonlinearity and complexity in economics and social science. His contributions to nonlinear economics were expansive, ranging from finance, to macroeconomics, ecological economics, behavioral economics, and other aspects of environmental science. He was also a long-time member of SCTPLS and a member of the NDPLS editorial board, and SCTPLS president from 2021 until early this year.

OVERVIEW: Economic and social systems are complex time-evolving systems, intrinsically dynamic and nonlin-ear. Nonlinearities and discontinuities arise naturally in several theoretical and applied contexts in macro-economics and finance, spatial and environmental economics, social and behavioral science. While linear dynamic models might serve as useful tools to approximate phenomena that are supposed to evolve towards equilibrium conditions - which is often the case under strong assumptions of homogeneity, rationality, and unlimited computational abilities of economic agents, as well as in the absence of 'market failures' - a number of real-world phenomena, including speculative bubbles and financial distress, regime changes, and even social and institutional evolution, cannot be fully understood without explicitly considering heterogeneity, bounded rationality and learning, social interaction, and the role of psychological phenomena and behavioral factors in individuals' decision making.

Moreover, many structural features of the broader economic-social-environmental landscape are intrinsically nonlinear, often discontinuous, characterized by inter-dependencies, amplification mechanisms and increasing complexity. Due to such features and factors, economic and social systems may evolve into a permanent chaotic regime that reflect patterns that differ profoundly from their linear approximation near a supposed equilibrium solution. A proper understanding of such evolving social, economic and environmental contexts requires an interdisciplinary approach and a wide spectrum of mathematical concepts and methods, ranging from the qualitative theory of nonlinear dynamical systems (including bifurcation analysis and chaos theory) to evolutionary games, from catastrophe theory to agent-based modelling techniques, from concepts and principles of behavioral science and economic psychology to nonlinear econometric techniques.

This special issue is aimed at contributing to the broad array of topics dealing with nonlinear and discontinuous phenomena in social, economic and environmental con-texts, with theoretical papers, simulation studies, empirical investigations. Areas and topics of particular interest include (not an exhaustive list):

Evolutionary economics
Ecological-economic dynamics
Structural change and growth
Speculative bubbles, crashes, and financial crises
Social interaction and learning
Economic complexity
Game theory, principles and applications
Agricultural economics
Socio-spatial economics
Multiple basin systems
Inflation and unemployment

Potential techniques include (not an exhaustive list):

Nonlinear dynamical systems simulations
Agent-based modeling
Nonlinear time series analysis
Catastrophe theory applications
Symbolic dynamics
Recursion quantification analysis
Self-organizing and emergent processes

The purview of the journal is critical to the inclusion of articles: *Nonlinear Dynamics, Psychology, and Life Sciences* publishes papers that augment the fundamental ways we understand, describe, model, and predict nonlinear phenomena in psychology and the life and social sciences. One or more of the following nonlinear concepts must be an explicit part of the exposition: attractors, bifurcations, chaos, fractals, solitons, catastrophes, self-organizing processes, cellular automata, genetic algorithms and related evolutionary processes, neural networks, and agent-based models. The broad mixture of the disciplines represented

here indicates that many bodies of knowledge share common principles. By juxtaposing developments in different fields within the life and social sciences, the scientific communities may obtain fresh perspectives on those common principles and their implications. Because the journal is multidisciplinary in scope, each article should constructed for understanding by a broad readership.

The project is planned on the following schedule:

- Abstracts for intended articles should arrive by July 15, 2023.
- Full-text papers need to arrive by October 15, 2023. Please send the manuscripts to the editor in chief and the special issue editors by e-mail (addresses below).
- Manuscripts should be prepared in APA style. Key style points and small variations that are specific to the journal can be found in the Instructions for Authors on the journal web site:

www.societyforchaostheory.org/ndpls/author_instructions/

- Reviews will be completed by December 15, 2023, or sooner to the extent possible.
- Revisions and final edits should be received by February 1, 2024.
- Publication in April, 2024.

We look forward to receiving your abstracts and papers. If you have any questions about the project, please do not hesitate to ask one of the editors below.

Sincerely,

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